Part

B

Section 9: Methods of Determining Marbled Murrelet Use of the Southern Humboldt Bioregion

Draft

METHODS OF DETERMINING MARBLED MURRELET USE OF THE SOUTHERN HUMBOLDT BIOREGION

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INTRODUCTION

We explored two metrics of the value to the Marbled Murrelet of various stands in the Southern Humboldt Bioregion: (1) the total land area utilized by the species, both presence and absence, and (2) the area weighted by the relative abundance of birds.

The number of hectares containing birds is relatively simple to calculate. However, giving some weight to bird use of the stands is more complex, but is consistent with traditional research and management involving animals and habitat. That is, habitat with more birds is more important to its conservation than habitat with few or no individuals. To determine the relative numbers of birds using different land ownerships and forest stands within the Bioregion, we first examined Marbled Murrelet habitat relationships within the region. One measure of the value to the birds of the different habitat types and stands (Fig. 1) can be extracted from detection levels observed during inland surveys. The value can be used to gain insight into the relative value of the stands of available habitat.

Our objective was to evaluate the habitat and the stands in the Bioregion, based on quantification of bird activity and behaviors, and then to apply that evaluation by ranking the existing habitat areas, including habitat that has not been surveyed.

The process we used followed five steps:
1. The habitats within 200 m of each survey station was delineated, using the 1992 vegetation coverage (Fig. 2).
2. The mean detection level at each station was associated with the 200 m radius.
3. The "detection intensity", the number of detections per ha, a measure of bird use, was calculated for each of the different habitat types, after assigning the detections of each station to one or more habitat types.
4. Several stations were combined to calculate the "Bird Value" for each stand by applying the detection intensity by habitat type
5. The percentage of the total Bird Value for the Bioregion was calculated for each stand.

. ASSUMPTION: BIRD DETECTION LEVELS ARE DIRECTLY PROPORTIONAL TO THE NUMBER **OF** BIRDS NESTING AT A SITE. A linear relationship between detections and number of nesting birds was

the underlying assumption. -There would be little doubt that within a range of variance the relationship is positive, but it has been suggested that social facilitation might cause birds at low densities to have fewer occasions to vocalize. Without **any** basis to determine the function of vocalizations, one **must** rely upon other species, where, with minor exceptions, more vocalizing birds are indicative **of** more birds in the habitat. Social facilitation is known, but again, is the exception, rather than the rule. It has also been suggested that nesting birds are silent, and only non-breeding birds are detected. While difficult to prove a negative, the observations of Witt et al. (in press) are consistent with the hypothesis that at least some nesting birds vocalize. If social facilitation results in higher vocalization rates at higher density levels, then a logarithmic transformation of the data should help to normalize such data. To conclude, the parsimonious view is that the relationship of density and vocalizations is linear or comparable at sites with varied bird densities.

● ASSUMPTION: BIRD DETECTION LEVELS CAN GIVE US SOME MEASURE OF TEE QUALITY OF THE HABITAT. That is, if comparing two stations in two different habitat types, the assumption is that the habitat with the higher number of detections is of more value to the birds. A vast array of literature supports this assumption, and the value has been used by all investigators of the species.

. ASSUMPTION: OUR DEFINITIONS OF THE "STANDS" ARE APPROPRIATE TO THE BIOLOGY OF THE BIRDS AND USEFUL FOR EVALUATING THE HABITAT. The stands, as we defined them (Fig. l), are contiguous (on 1992 map) patches **of** habitat containing tree species and structural characteristics identified in the literature and current research as important for the murrelet. They are independent of economic and political concerns.

. ASSUMPTION: DESPITE A MARKED DECLINE IN OLD-GROWTH AND RESIDUAL OVER THE 1992-6 PERIOD, THE NUMBER OF BIRDS IN THE BIOREGION WAS ESSENTIALLY THE SAKE IN 1996 (Table 1). It can easily be argued that the significant decline in potential habitat that we found would be reflected in an increase in relative density in the remaining habitat. It could also as easily be argued that because most of the habitat removed was highly fragmented and of relatively low value, the **few** birds using this habitat would have moved to other areas.

DATA SOURCES FOR SURVEYS OF BIRDS IN FORESTS

Protocol and methods
        Surveys for murrelets in forests were conducted from 1992 through 1997 according to the Pacific Seabird Group's (PSG) "Methods of surveying Marbled Murrelets at inland forested sites" (Ralph et al. 1990, 1992, 1993, 1994). The basic datum used is the average number of observations of birds and the behavior types observed at each station location during one survey morning (a minimum two hour period beginning 45 minutes before sunrise). Surveys were conducted throughout the breeding season, from April through early August.
        The initial survey Protocol (Paton et al. 1990) was modified as results of additional analyses became available. Modifications generally involved the spatial distribution of stations, and the number of surveys during the season and did not

alter the compatibility of survey results. Most stations or "sites" (a 120 acre area of surveys, per PSG protocol) were surveyed a minimum of two consecutive years, and a total of four times.

● ASSUMPTION: NEARBY STATIONS WERE STATISTICALLY INDEPENDENT OF EACH OTHER. Most stations were distributed throughout the habitat type of a stand, but some 200-m buffers around a station overlapped, and presumably could be estimating the same population. Given the day to day variation in detection rates, we assumed that independence of stations played little role in our analyses, as stations with overlapping circles were not surveyed on the same day.

. ASSUMPTION: STATIONS WITH DIFFERENT INTENSITIES OF SURVEY EFFORT WERE EQUAL. Data from one or more surveys at each station were combined for a mean value of standardized detections. This undervalued the contribution of stations with many surveys, and tended to overvalue those with few. The majority had about 4-6 surveys at each station. At this level of survey effort, we feel that any problems due to variance would be minor and we are continuing our analyses to quantify the effects.

Sources of Survey Results

Survey results were gathered and compiled from several sources and had been collected for different objectives.

Pacific Lumber Company (Palco).--The company contributed all the surveys on their properties for land management consultations conducted between 1992 and 1997 by their personnel and consultants. Some additional surveys were conducted at possible nest trees. We obtained these data after they were entered, and we spot-checked them for accuracy with the original data. In addition, the company contracted with consultants in various years to survey additional areas of the parks in the Bioregion. These data were directly deposited with Redwood Sciences Laboratory for checking, data entry, and analyses.

Redwood Sciences Laboratory.--We had data from two studies. The first was during 1992 when stands of varied sizes on Palco land and the state parks were surveyed to determine presence of birds in stands. Four surveys were conducted throughout the breeding season at each stand. The second was in 1993, when the state and national parks in Humboldt County were surveyed to examine the habitat relationships of the murrelet in large contiguous stands of old-growth forest. The stations, each surveyed once during the season, were positioned 400 m apart in all accessible areas.

● ASSUMPTION: ALL DATA ARE EQUAL IN METHODS AND QUALITY. All observers participated in similar training and testing workshops. Data forms and records of submission **of** data for the various timber review processes were available to us for examination. In examination of the data, we could find no difference in the results, in a given stand or area, between data taken by Redwood Sciences Laboratory personnel and any other entity.

Data Preparation for Analyses

Standardization for seasonal activity levels .--The level of murrelet activity at nesting stands generally follows a pattern of increasing detections from April to July (O'Donnell et al. 1995). By early August, detection levels rapidly decrease, presumably after most of the young have fledged. This was the principal source of variation in detections (Ralph et al. in prep). Other sources of variation (e.g., weather, moon phase, tide, etc.) can account for less than 5 percent of the variation. Before comparing detection levels at different stations or stands, we first standardized survey results for seasonal variation using methods reported in Miller and Ralph (1995).

Calculation of **mean** *standardized detection.--We* calculated the mean of the standardized detections for each station, resulting in the metric, the "mean standardized detection". To calculate this, we used the detections from all the mornings a given station was surveyed.

Status (Behaviors) .--Some behaviors observed during surveys are assumed to be associated with nesting birds, as discussed in the Protocol (Ralph et al., 1994). These include any flight below the top of the canopy and circling above the stand. If these behaviors are seen, then we consider it likely that birds are nesting in the area around the station and the station had a status of "occupied." If birds are detected, but no occupied behaviors are observed then the status was "presence." For analyses, results of all surveys at a station were tallied and the station was assigned the most significant status, in this hierarchical order: (1) occupied, (2) presence, or (3) no detections.

DATA SOURCES FOR INLAND FOREST HABITATS

We obtained forest habitat maps of the bioregion in a GIS format from a number of sources.

Palco lands

For this ownership, three sources were identified: the California Timber Task Force (CTTF) maps developed for the State of California by Geographic Resource Solutions; the Klamath Mountains Bioregional Analysis (Larry Fox [Humboldt State University], USFWS, BLM, and others); and Pacific Lumber Company's timber type maps. We also consulted aerial photos and a S.P.O.T. map (SPOT Image Corp. 1994) for many of the stands.

Map selection for analyses

The various coverages were compared visually and, as expected with varied classification systems and data sources, we observed some differences in patch locations and size for many habitat classifications. However, the boundaries, locations, and areas of stands of unharvested old-growth and of the denser residual trees were very similar, particularly for the Palco and Klamath Mountain Bioregion maps. The three maps are now

available in digital form and we will complete the comparison by' quantifying the similarities and differences.

    We selected the Palco maps for analyses, because we judged from comparison with other sources that they contained the highest level of accuracy of stand boundaries. Vegetation plot data from Palco and Redwood Sciences Laboratory are available for classification verification.

Methods

    Photo interpretation and digitizing was conducted by Hammond, Jensen, and Wallen, Co. (1992, 1996) who used interpretation of aerial photographs to designate the boundaries for patches of contiguous habitat. Then, Palco digitized the boundaries to create the maps used for analyses. The map was updated each year to include changes in habitat polygon boundaries or classifications. We verified classifications from vegetation data that were collected independently at many of the stations.

1992 vs. 1996 coverages

    We used maps from both 1992 and 1996 for our analyses. Beginning in 1992, surveys were conducted in stands considered potential murrelet habitat. If the stand was logged and the area around a survey station was no longer considered potential habitat then no further surveys were done at the station. Therefore, the 1992 map best represented the station habitat type during the surveys and we used this map for identifying murrelet activity and habitat relationships. The 1996 map, which provides an estimate of the current conditions, was used to evaluate the potential importance of the remaining stands.

Timber classes

    The Pacific Lumber Company used ninety-nine timber classes based upon attributes that describe contiguous habitat patches (Appendix 1). The attributes include: size of the old-growth, residual and second growth trees, tree species, percent of canopy cover of the dominant and codominant trees, understory and non-timber classes (i.e. hardwoods, brush, grass), and recent clearcuts. Major classes describe the general vegetation, while minor classes provide information at a more detailed scale. For this analysis, we used only the major classes.

Aggregation of classes

    To allow comparisons of stands throughout the bioregion, we aggregated the major timber classes into 12 potential murrelet habitat types (Table 2, Fig. 3). The types included: (1) old-growth or residual trees, (2) 5-25, 25-50, 50-75 or 75-100 percent canopy cover, (3) and tree species (redwood, mixed redwood and Douglas-fir, or Douglas-fir). All other timber classes were aggregated to "non-habitat."

      ● ASSUMPTION: THE TIMBER TYPES FROM THESE SOURCES ACCURATELY REFLECT THE TYPES ON THE GROUND. Our comparison between the various sources, and the high degree of agreement of

types and polygon boundaries, indicated strongly that we could rely upon the various base maps across ownerships.

● ASSUMPTION: THE TIMBER TYPE AGGREGATIONS USED IN THE ANALYSES ARE APPROPRIATE FOR UNDERSTANDING MURRELET HABITAT USE. Literature on the murrelet indicate old-growth (unharvested and residual) stands as the most likely to contain nesting **birds** (Hamer and Nelson 1995, Miller and Ralph 1995, USDI 1995).

Designation of stands
From the maps of habitat polygons, we designated 'stands' (Fig. 1). These are areas of contiguous patches of potential habitat (old-growth and residual), that are less than 150 m apart. For some stands we adjusted boundaries to geographic or human features, e.g., ridges, streams, or roads.

Humboldt Redwoods State Park
Palco provided a timber class map for the Park, however it did not use the same 99 classes as was used for the Palco ownership. Therefore, a great deal of adjusting had to be accomplished. The map was created for Palco by Hammond, Jensen, and Wallen, Co. using interpretation of aerial photographs to designate the boundaries for patches of contiguous classes. Patch boundaries were digitized by Palco.

Timber classes
The 13 timber classes that were available for the Park (Appendix 2) were broader than those on Palco lands, and considered fewer structure attributes and no tree species information. The eight classes of potential murrelet habitat were aggregated to four classes to be used for analyses.

Species data for the Park
The second data source for the Park, obtained in 1992 from Gary Emery at Humboldt State University, was a coverage of vegetation types defined by dominant plant species. For the current analysis, we selected only those areas of the map designated as old-growth forests. Emery obtained the old-growth information from a classification of old-growth forest habitat occurring within the Bull Creek watershed and compiled **by** Matthews (1986). Old-growth was defined using low altitude aerial photographs, USDA soil-vegetation maps, and other relevant data. In addition, vegetation measurements from 120 releve samples (Matthews 1986) were used to further define five distinct vegetation classifications. Old-growth classifications were: (1) redwood with oxalis (Sequoia sempervirens/Oxalis oregana), (2) redwood/Douglas-fir with salal understory (Sequoia sempervirens/Pseudotsuga menziesii, Gaultheria shallon),(3) redwood/Douglas-fir with huckleberry (Vaccinium ovatum) understory, (4) redwood/Douglas-fir with madrone (Arbutus menziesii) understory, and (5) Douglas-fir. Matthews (pers. comm.) found 80 percent accuracy rate for a predictive model based on the classification types.

Overlay of timber class and species maps
     We combined the two data sources (timber class and species)
to provide 12 habitat classes (Table 2, Fig. 4) from the parks
that could be compared with Palco land for analyses.
     During the overlay process, some new polygons (less than 1
ha) were created by the differences in patch boundaries. These
areas were considered an artifact of the overlay and were
appended to the habitat type with which they shared the longest
common boundary. Differences in patch boundaries also created
polygons on the Palco coverage that did not overlap with the
Emery coverage and the reverse. For incomplete habitat types,
the class or species of the adjacent habitat type was assigned.

ASSIGNING DETECTIONS TO HABITAT TYPES

     Before determining activity levels for stands, the detection
level at each station was assigned to the habitat types surveyed
by the station.

Area Surveyed
     As reported in the Protocol (Ralph et al. 1993) the average
maximum distance for audio detections was approximately 200 m, so
we used that distance around each station. This resulted in an
area of approximately 12.5 ha. Using the 1992 vegetation map, we
then identified the different habitat types within each 12.5 ha
circle.

          ● ASSUMPTION: THE NUMBER OF DETECTIONS AT A STATION ARE
          ASSUMED TO REPRESENT THE BIRD ACTIVITY LEVEL FOR THE HABITAT TYPES
          WITHIN THE 200-m STATION HABITAT CIRCLE. Given that the species
          in the forest can be seen flying over an area of at least 12.5 ha,
          we felt that this area was conservative.

          . ASSUMPTION: THE STATION LOCATIONS, AS SUPPLIED TO REDWOOD
          SCIENCES LABORATORY, ARE CORRECTLY POSITIONED GEOGRAPHICALLY.
          Repeated checking of stations with aerial photography, field
          station maps, and the various coverages indicated strongly that
          the great majority of stations were located at the true location
          of the observer at the station.

Habitat types
     The detection level at each station was then associated with
the habitat within a 200-m radius (the 'station habitat circle,'
Fig. 2) around the station location.
     Many of the 200-m circles contained more than one habitat
type. We developed three methods for allocating detections to
station habitat types:

          Method 1 assigns all detections at a station to one habitat
          type and incorporates an assessment of the most likely
          habitat the birds might use based on our understanding of
          the bird's biology.

Method 2 also assigns all detections at a station to one habitat type, using the most abundant habitat types.

Method 3 incorporates all of the habitat types within the station habitat circle and assigns detections proportionally to the amount of each habitat within the circle.

METHOD 1, the "Most Likely" Nearby-habitat Method
     The two habitat types comprising the two largest areas within the circle are compared. The detections are assigned to one of those two types, as determined by the decision processes below (Figs. 3 and 4).

Pacific Lumber Company Land
     We designated 12 old-growth and residual habitat types, differentiated by two attributes: percentage of canopy cover, and tree species. The survey area of 12.5 ha was treated as if it was composed entirely of the one "most likely" habitat type. The habitat type assigned to each station was determined by a scheme (Fig. 3) following these rules:
     1. When comparing two different habitat types, if each was in a different canopy cover class, then the detections were assigned to the type with the higher percentage of canopy cover, regardless of tree species type.
     2. When comparing two different habitat types within the **same canopy cover class,** if one was a mixture of **redwood and Douglas-fir,** and the other was redwood, then the detections were assigned to redwood.
     3. When comparing two different habitat types within the **same canopy cover class,** if one type **was Douglas-fir,** then regardless of the second type, the detections were assigned to the habitat type that has the larger amount of **area** within the circle.
     4. Similar to 3, when comparing two different habitat types within the same **canopy** *cover* **class,** if one type was **residual,** then, regardless of the second type, the detections were assigned to the habitat type that **has** the larger amount of area within the circle.

Humboldt Redwoods State Park
     The Park also has 12 old-growth and residual habitat types, differentiated by percentage of canopy cover, and tree species. The 12.5-ha station habitat circles separately were assigned a timber class and a species designation according to the following rules (Fig. 4):
     Timber class designation.--The two timber classes which covered the two largest areas in the circle were compared. There were three possible cases for comparison:
          1. If either class **was old-growth with over 50 percent cover,** then the detections were assigned to that class.
          2. If neither of the two largest-area classes was old-growth with over 50 percent cover, but one of them was

residual with **over** 50 percent cover, then the detections were assigned to that class.

3. Otherwise, the two largest-area classes must be old-growth with under 50 percent cover and residual with under 50 percent cover, in which case the type with the larger amount of area was assigned to that station.

Tree *species designation*.--The two Emery tree/understory types comprising the largest areas within the 200-m station habitat circles were compared. There were two situations that could occur.

1. If one of the two types was a mixture of redwood and Douglas-fir (types 2, 3, or 4), and the other was redwood (type 1), then the station was assigned to redwood.

2. If one of the two types was Douglas-fir (type 5), then, regardless of the other type, the station was assigned the type with the larger amount of area within the circle.

The habitat type assigned to each station in the Park was the paired timber class and tree/understory designations. The survey area of 12.5 ha was then treated as if it was composed entirely of this one "most likely" habitat type.

. ASSUMPTIONS: THE DETECTIONS HEARD AND OBSERVED AT A SURVEY STATION RESULTED FROM BEHAVIOR ASSOCIATED WITH THE "MOST LIKELY" HABITAT TYPE.

- The birds prefer areas with a higher percentage of canopy cover, regardless of tree species type.
- Where a survey station was near both redwood and a mixture of redwood and Douglas-fir, and both were in the same canopy cover class, any detections were more likely to be associated with redwood.
- Where a survey station was near both Douglas-fir and a second type of habitat, regardless **of** type, and both were in the same canopy cover class, then any bird activity was more likely to be associated with the type which comprised the greater area within the 200-m habitat circle surrounding the station.
- Where a survey station was near both residual and a second habitat type, and both were in the same category of canopy cover, then any bird activity was more likely to be associated with the type which comprised the greater area within the 200-m habitat circle surrounding the station.

Based on our research in the habitat, we feel that the above assumptions are reasonable.

METHOD 2, the "Most Abundant" Method

The areas **of** the different habitat types within the station circle are compared. The station was assigned the habitat type that comprises the largest amount of area. All of the station's detections are attributed to this one habitat type. The survey area of 12.5 ha was then treated as if it was composed entirely of this one "dominant" habitat type.

- ASSUMPTION: THE DETECTIONS HEARD AND OBSERVED AT A SURVEY STATION RESULTED FROM BEHAVIOR ASSOCIATED WITH THE HABITAT COMPRISING THE LARGEST AMOUNT OF AREA. This was a reasonable assumption, but does ignore the real possibility that the birds

are associated with the most favorable habitat within the 12.5 ha circle.

METHOD 3, the "Proportional" Method

The areas of each **of** the habitat types within the station habitat circle are determined. Areas considered to be "non-habitat" are ignored in all 3 methods. The resulting "habitat" areas are considered to account for 100 percent of the station's detections. For each habitat type present in the circle, the detections attributed to that station are portioned out to the different habitat types, so that the fraction of the detections assigned to any type was equivalent to the fraction of the available habitat of that type within the circle. The end product, for each station, was the number of detections which are assigned to each habitat type, along with the actual area present in the circle for each habitat type. Note that in this case, the total of "the areas of "habitat" in the 200-m circle was not more than 12.5 ha, and, in fact, would be less than 12.5 ha if there was any area of "non-habitat" within the circle.

● **ASSUMPTION: THE DETECTION LEVEL AT A STATION WAS EQUALLY LIKELY TO BE ATTRIBUTED TO ANY OF THE HABITAT TYPES IN THE AREA SURROUNDING THE STATION (EXCLUDING THE "NON-HABITAT" AREAS). This** also assumes that the birds are not selecting more preferred habitat in the circle. Again, this is a reasonable assumption, depending upon the birds' behavior.

CALCULATING BIRD VALUES

For each stand the "detection intensity", a measure of bird use, was calculated for each of the different habitat types. The mean standardized detections of each station have been assigned habitat types by one of the above methods and each habitat type now has both detections attributed to it and an associated amount **of** area. The detections and the amount of area for each habitat type are totaled. The total detections divided by the total area was the *'detection intensity' for that habitat type, for that stand. The stand has a calculated "detection intensity" value for the different habitat types.

The detection intensity (detections/ha) for each habitat type was multiplied by the number of hectares of that type in the stand (as it appears on the 1996 map) and the result was a detection value for each habitat type.' The detection values for all habitat types in the stand were totaled to give a "Bird Value" for the stand.

PRELIMINARY RESULTS

The Percentace of Bird Value

The Total Bird Value for the entire region was found by summing the Values for all the stands and the percentage of the Total Bird Value was calculated for each stand. The stands can then be compared by their relative level of murrelet use (Table 3; Fig. 5).

We found that each stand contributed comparable percentages (differing by 4-5 percentage points at most) with all three methods, with the exception of Stand 25 "Park South." Here, while Methods 1 and 2, 1.0 and 0.6 percent respectively, were similar, Method 3 resulted in 6.3 percent of the population. Since Method 3 attributed detection values by a proportional allocation, some habitat types were allocated more detection in this method than in either of the other two methods. The two stations (of 62 stations) in this stand with non-zero detections were both located near old-growth redwood and old-growth redwood/Douglas-fir. With Methods 1 and 2, all of the detections were assigned to one of the habitat types for each station, but with Method 3, both stations contributed to both habitat types. The redwood/Douglas-fir type constitutes about 300 times more area within this stand, and the detections from these two stations contributed greatly to the extrapolation to the 2524 ha of this habitat type in the stand.

Assigning Bird Values for Ranking of Stands

We compared two metrics for use in ranking the stands: (1) the percent of the total area of old-growth and residual habitat in each stand and (2) the Bird Value (percent of total detection values), both resulting from extrapolation by Method 1. For many stands, results of the two metrics were similar (Fig. 6). However, five stands showed a marked difference: the three Park stands, Headwaters, and the matrix of all remaining Palco habitat. The relative value to the birds, as compared to other stands, of the largest stands (Headwaters, and the two northern Park stands) was much larger when we considered detections, as compared to only habitat area. By contrast, the Park South stand contains over 20 percent of the area of the Bioregion, but represents less than 1 percent of the Bird Value when detections are used. This stand is farther from the coast and the habitat is likely to be warmer in the summer months than the northern Park stands. The habitat in all remaining Palco habitat is almost 30 percent of the area, but the low numbers of detections assign less than 2 percent of the Bird Value to this "stand".

Bird Values Calculations Using Occupied Detections

We compared Bird Values, calculated using Method 1, for all stands using all detections, with Bird Values using occupied detections only. We found a difference of less than 2 percentage points in the resulting values for most stands (Fig. 7). Two stands in the agreement area (Headwaters and Elkhead Springs) and the southern-most Park stand (Stand 25), had Bird Values that were approximately 5 percentage points higher based on occupied detections only. The Bird Value for the North-Central Park stand (Stand 23-24) decreased by approximately 11 percentage points when only occupied detections were used. In this stand, which included Bull Creek and the related upland old-growth, only about one-third of the stations (compared to, for example, two-thirds in Headwaters, Stand 6) had occupied behaviors. This reduced the total occupied detections for the stand and, therefore, the resultant Bird Value. We do not feel that the detection rate was

lower in the Park stands, but that this could reflect actual
degree of occupancy, with the farther inland and drier Park
having a somewhat lower occupancy rate.

ADDITIONAL ANALYSES

Bird habitat relationshin
        We are continuing to examine the relationships between
murrelet detection numbers and status (occupied, presence, or no
detections), habitat types and landscape features.
        We are analyzing the habitat and stand maps using Fragstats
(McGarigal and Marks 1994), a computer program that generates a
set of statistics to quantify various landscape qualities. Some
metrics we will examine include: areas, patch density, edge to
area ratios, a shape index, core area, interspersion and nearest
neighbor values. The set of landscape variables will be combined
with birds and habitat variables and analyzed using multiple and
logistic regression and principle components analysis. We are
certain that these will help us to further understand bird use
patterns and more precisely define habitat quality for the
murrelet. Further, they will provide factors that will more
accurately weight the bird values for future analyses.

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TABLE 1. Estimated changes in habitat area (1992 - 1996) in hectares.

OLD GROWTH

Class	Area in 1992	Area in 1996	Percent change
O1/R	365.0	311.6	-14.6
O1/RD	1242.5	1194.0	-3.9
O1/D	222.9	144.7	-35.1
02/R	104.6	93.2	-11.0
O2/RD	439.1	331.8	-24.4
02/D	460.2	307.0	-15.7
03/RD	190.7	170.5	-10.6
03/D	641.2	581.6	-9.3
04/D	849.6	701.0	-8.0
All Old-growth	4515.9	3997.0	-11.5

RESIDUAL

	Area in 1992	Area in 1996	Percent change
R2	509.6	325.0	-36.2
R3	3946.8	2219.0	-43.8
R4	10492.8	6495.7	-38.1
All Residual	14949.1	9039.7	-39.5
Total	19465.1	13036.8	-33.0

We summarized the changes in land areas attributed to each of the aggregated habitat types of potential murrelet habitat between 1992 and 1996 on Pacific Lumber Company land. Areas are from Arc/INFO vegetation coverages provided by Palco and validated by our laboratory. The percentage changes in area are for each habitat type over the 4-year span of the data sets. The changes were apparently concentrated in stands of residual trees. Summaries are given for combined old-growth types, residual types, and overall total.

Table 2. Habitat types used in analysis. Each has corresponding designations and descriptions for lands owned by Pacific Lumber Company (PALCO) and within Humboldt Redwoods State Park (HRSP). Type information for PALCO and HRSP was not grouped in the same way. Note that Canopy Cover was broken into 4 classes on PALCO land (1, 75-100%; 2, SO-75%, etc.) and 2 classes in HRSP (1, over 50%; 2, under 50%). See text.

Habitat Type	PALCO Type Designation	PALCO Description	HRSP Type Designation	HRSP Description
1	O1/R	Old-growth Redwood 75- 100% Canopy Cover	O1/R	old-growth Redwood SO-100% Canopy Cover
2	O1/RD	Old-growth Redwood/Douglas-fir mix 75-100% Canopy Cover	O1/RD	old-growth Redwood/Douglas-fir mix 50-100% Canopy Cover
3	O1/D	Old-growth Douglas-fir 75-100% Canopy Cover	O1/D	Old-growth Douglas-fir SO-100% Canopy Cover
4	O2/R	Old-growth Redwood 50-75% Canopy Cover	O2/R	Old-growth Redwood 0-50% Canopy Cover
5	O2/RD	Old-growth Redwood/Douglas-fir mix 50-75% Canopy Cover	O2/RD	Old-growth Redwood/Douglas-fir mix 0-50% Canopy Cover
6	O2/D	Old-growth Douglas-fir SO-75% Canopy Cover	O2/D	Old-growth Douglas-fir O-50% Canopy Cover
7	R2	Residual SO-75% Canopy Cover	R1/R	Residual Redwood SO-100% Canopy Cover
a	O3/RD	old-growth Redwood/Douglas-fir mix 25-50% Canopy Cover	R1/RD	Residual Redwood/Douglas-fir mix 50-100% Canopy Cover
9	O3/D	Old-growth Douglas-fir 25-50% Canopy Cover	R1/D	Residual Douglas-fir 50-100% Canopy Cover
10	R3	Residual 25-50% Canopy Cover	R2/R	Residual Redwood 0-50% Canopy Cover
11	OS/D	old-growth Douglas-fir 5-25% Canopy Cover	R2/RD	Residual Redwood/Douglas-fir mix 0-50% Canopy Cover
12	R4	Residual 5-25% Canopy Cover	R2/D	Residual Douglas-fir 0-50% Canopy Cover
13	NH	Non-Habitat	NH	Non-Habitat

TABLE 3. Results of *Bird* Value Analysis using Method 1.

   The habitat analysis here uses Method 1, the "Most Likely Habitat" method. The stand numbers correspond to stands designated on Figure 1. Also provided are our stand names with the totals of each stand's data. The types (Type) are the 12 aggregated habitat types (Table 2). Note that the designations for the three park stands follow a slightly different system due to differences in the original vegetation classifications. For this analysis, Stands 23 (Park North) and 24 (Park Central) have been combined and are listed as Stand 23. Stand 22 represents all Palco property outside of the 21 designated Palco stands, which we refer to as the 'matrix'.
   The "mean standardized detections" (MeanStdDet) is the sum of the mean standardized detections for all stations assigned to each of the 12 habitat types. The "station hectares" (Sta-ha) is the total area of stations assigned to the habitat type. Because all of the approximately 12.5 ha of each station habitat circle are assigned to a single habitat type, values in this column will be multiples of about 12.5.
   The "detection intensity" (Det/ha92) is the mean standardized detections divided by the station hectares, based on the 1992 coverage, that is, the detection rate per hectare of assigned habitat. The total area of each habitat type within a' stand is provided for both the 1992 ("92ha") and 1996 ("96ha") maps.   (These data are summarized in Table 1)
   The detection intensity at the time surveys were conducted (based on 1992 stand areas) was multiplied by the amount of available habitat in 1996, and then summed for all habitat types for the total detection value. The percentage shown for each stand is the "Bird Value," the percentage that the total detection value for that stand is of the grand total of detection values for all stands. The Bird Value for each stand is then relative to all stands in the Southern Humboldt Bioregion.

Table 3. **Results** of Bird Value Analysis wing Method **1** continued. Page **2.**

Stand		Type	MeanStdDet	Sta-ha	Det/ha92	92ha	96ha	96ha*(Det/ha92)
1	1	O1/R	0.000	0.00	0.0000	0.00	0.00	0.0000
1	2	O1/RD	0.000	0.00	0.0000	0.00	0.00	0.0000
1	3	O1/D	0.000	0.00	0 .oooo	0.00	0.00	0.0000
1	4	02/R	0.000	0.00	0.0000	0.00	0.00	0.0000
1	5	O2/RD	0.320	37.51	0.0085	6.78	6.77	0.0578
1	6	02/D	0.000	0.00	0.0000	0.00	0.00	0.0000
1	7	R2	(I.000	0.00	0.0000	10.57	10.57	0.0000
1	8	O3/RD	0.000	0.00	0.0000	0.00	0.00	0.0000
1	9	03/D	0.000	0.00	0.0000	0.00	0.00	0.0000
1	10	R3	0.000	12.50	0.0000	2.88	2.89	0 .oooo
1	11	04 /D	0.000	0.00	0.0000	0.00	0.00	0.0000
1	12	R4	0.000	0.00	0.0000	91.11	83.55	0.0000
			========			====a---	=====a==	===a====
Freshwater			0.320			111.34	103.78	0.0578	0.00%

Stand		Type	MeanStdDet	Sta-ha	Det/ha92	92ha	96ha	96ha*(Det/ha92)
2	1	O1/R	0.000	0.00	0.0000	0.00	0.00	0.0000
2	2	O1/RD	0.000	0.00	0.0000	0.00	0.00	0.0000
2	3	O1/D	0.000	0.00	0.0000	0.00	0.00	0.0000
2	4	02/R	0.000	0.00	0.0000	0.00	0.00	0.0000
2	5	O2/RD	0.000	0.00	0.0000	0.00	0.00	0.0000
2	6	02/D	0.000	0.00	0.0000	0.00	0.00	0.0000
2	7	R2	0.000	0.00	0.0000	4.43	4.42	0.0000
2	8	O3/RD	0.000	0.00	0.0000	0.00	0.00	0.0000
2	9	03/D	0.000	0.00	0.0000	0.00	0.00	0.0000
2	10	R3	0.000	12.50	0.0000	15.63	13.42	0.0000
2	11	04/D	0.000	0.00	0.0000	0.00	0.00	0.0000
2	12	R4	29.590	62.51	0.4734	233.54	203.27	96.2185
			========			========	========	==e==m==
Fork Elk R. NW			29.590			253.60	221.11	96.2185	3.32%

Stand		Type	MeanStdDet	Sta-ha	Det/ha92	92ha	96ha	96ha*(Det/ha92)
3	1	O1/R	1.540	12.50	0.1232	3.47	1.45	0.1791
3	2	O1/RD	95.940	187.53	0.5116	126.69	125.90	64.4071
3	3	O1/D	37.380	87.52	0.4271	35.92	35.92	15.3406
3	4	02/R	0.000	0.00	0.0000	4.27	4.25	0.0000
3	5	O2/RD	0.000	0.00	0.0000	5.59	5.60	0.0000
3	6	02/D	0.000	12.50	0.0000	8.11	8.12	0.0000
3	7	R2	0.000	0.00	0.0000	4.98	0.23	0.0000
3	8	O3/RD	0.000	0.00	0.0000	0.00	0.00	0.0000
3	9	03/D	24.360	87.52	0.2783	19.90	19.88	5.5343
3	10	R3	1.980	87.52	0.0226	142.60	64.29	1.4546
3	11	04 /D	0.000	0.00	0.0000	0.00	0.00	0.0000
3	12	R4	0.000	75.01	0.0000	260.20	151.85	0.0000
Bell Lawrence -			==m===e=			========	========	========
Booths Run			161.200			611.73	417.49	86.9157	3.00%

Stand		Type	MeanStdDet	Sta-ha	Det/ha92	92ha	96ha	96ha*(Det/ha92)
4	1	O1/R	0.000	0.00	0.0000	0.00	0.00	0.0000
4	2	O1/RD	0.000	0.00	0.0000	0.00	0.00	0.0000
4	3	O1/D	0.000	0.00	0.0000	0.00	0.00	0.0000
4	4	02/R	0.000	0.00	0.0000	0.00	0.00	0.0000
4	5	O2/RD	0.000	0.00	0.0000	0.00	0.00	0.0000
4	6	02/D	0.000	0.00	0.0000	0.00	0.00	0.0000
4	7	R2	7.200	75.01	0.0960	16.33	16.32	1.5664
4	8	O3/RD	0.000	0.00	0.0000	0.00	0.00	0.0000
	9	03/D	0.000	0.00	0.0000	0.00	0.00	0.0000
*			8.800	50.01	0.1760	34.91	34.79	6.1218
4	10 11 04 R3 /D		0.000	0.00	0.0000	0.00	0.00	0.0000
4	12	R4	39.390	150.03	0.2626	361.63	295.51	77.5857
			---------			========	========	========
1. Fork Elk R. SE			55.390			412.87	346.62	85.2738	2.94%

Stand		Type	MeanStdDet	Sta-ha	Det/ha92	92ha	96ha	96ha*(Det/ha92)	
5	1	O1/R	0.420	12.50	0.0336	4.97	4.30	0.1444	
5	2	O1/RD	19.480	62.51	0.3116	16.87	5.30	1.6523	
5	3	O1/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
5	4	O2/R	4.470	25.00	0.1788	3.98	1.54	0.2756	
5	5	O2/RD	0.000	0.00	0.0000	0.00	0.00	0.0000	
5	6	O2/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
5	7	R2	0.000	0.00	0.0000	0.00	5.37	0.0000	
5	8	O3/RD	0.000	0.00	0.0000	0.00	0.00	0.0000	
5	9	O3/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
5	10	R3	68.910	125.02	0.5512	202.41	93.64	51.6139	
5	11	O4/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
5	12	R4	0.000	25.00	0.0000	522.90	242.77	0.0000	
Rd 11 - Boulder Cr			93.280			751.13	352.92	53.6862	1.85%

Stand		Type	MeanStdDet	Sta-ha	Det/ha92	92ha	96ha	96ha*(Det/ha92)	
6	1	O1/R	325.440	275.05	1.1832	225.73	223.76	264.7490	
6	2	O1/RD	139.580	237.54	0.5876	706.78	695.96	408.9458	
6	3	O1/D	0 .000	0.00	0.0000	0.00	0.00	0.0000	
6	4	O2/R	49.710	62.51	0.7952	SO.78	49.88	39.6617	
6	5	O2/RD	0.000	0.00	0.0000	89.21	81.73	0 .0000	
6	6	O2/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
6	7	R2	0.000	0.00	0.0000	16.00	0.00	0.0000	
6	8	O3/RD	0.000	0.00	0.0000	89.32	85.51	0.0000	
6	9	O3/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
6	10	R3	4.210	25.00	0.1684	131.80	64.22	10.8135	
6	11	O4/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
6	12	R4	0.000	0.00	0.0000	185.69	106.12	0.0000	
Headwaters			518.940			1495.31	1307.18	724.1699.	24.97%

Stand		Type	MeanStdDet	Sta-ha	Det/ha92	92ha	96ha	96ha*(Det/ha92)	
7	1	O1/R	21.140	25.00	0.8454	5.71	5.70	4.8229	
7	2	O1/RD	0.000	0.00	0.0000	0.00	0.00	0.0000	
7	3	O1/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
7	4	O2/R	47.550	75.01	0.6339	35.67	35.64	22.5916	
7	5	O2/RD	20.690	100.02	0.2069	68.79	69.15	14.3047	
7	6	O2/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
7	7	R2	5.610	12.50	0.4487	10.14	8.85	3.9732	
7	8	O3/RD	0.000	0.00	0.0000	13.69	13.70	0.0000	
7	9	O3/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
7	10	R3	62.630	100.02	0.6262	203.90	97.79	61.2363	
7	11	O4/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
7	12	R4	0.000	0.00	0.0000	146.52	44.42	0.0000	
Elkhead Springs			157.620			484.42	275.25	106.9287	3.69%

Stand		Type	MeanStdDet	Sta-ha	Det/ha92	92ha	96ha	96ha*(Det/ha92)	
8	1	O1/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
8	2	O1/RD	0.000	0.00	0.0000	0.00	0.00	0.0000	
8	3	O1/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
8	4	O2/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
8	5	O2/RD	0.000	12.50	0.0000	1.98	0.00	0 . 0 0 0 0	
8	6	O2/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
8	7	R2	0.200	12.50	0.0160	5.77	5.77	0.0922	
8	8	O3/RD	1.370	25.00	0.0548	10.81	8.60	0.4711	
8	9	O3/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
8	10	R3	1.770	100.02	0.0177	75.36	131.17	2.3213	
8	11	O4/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
8	12	R4	3.920	175.03	0.0224	297.80	51.07	1.1439	
Below Rd 7 - Below Ad 9			7.260			391.72	196.61	4.0284	0.14%

Stand		Type	MeanStdDet	Sta-ha	Det/ha92	92ha	96ha	96ha*(Det/ha92)	
9	1	O1/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
9	2	O1/RD	105.370	250.05	0.4214	131.83	129.67	54.6445	
9	3	O1/D	4.020	12.50	0.3215	7.32	7.32	2.3546	
9	4	O2/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
9	5	O2/RD	0.000	0.00	0.0000	2.38	2.37	0.0000	
9	6	O2/D	(I.000	0.00	0.0000	5.32	5.32	0.0000	
9	7	R2	0.000	0.00	0.0000	0.00	0.00	0.0000	
9	8	O3/RD	0.000	0.00	0.0000	2.58	2.55	0.0000	
9	9	O3/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
9	10	R3	11.570	75.01	0.1542	217.94	56.91	8.7782	
9	11	O4/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
9	12	R4	0.000	12.50	0.0000	222.17	82.85	0.0000	
Shaw - Gift ·			========			========	===e=-w=	========	
Rd 9			120.960			589.54	286.99	65.7774	2.27%

Stand		Type	MeanStdDet	Sta-ha	Det/ha92	92ha	96ha	96ha*(Det/ha92)	
10	1	O1/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
10	2	O1/RD	0.000	0.00	0.0000	0.00	0.00	0.0000	
10	3	O1/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
10	4	O2/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
10	5	O2/RD	0.000	0.00	0.0000	0.00	0.00	0.0000	
10	6	O2/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
10	7	R2	37.560	275.05	0.1366	60.98	61.22	8.3606	
10	8	O3/RD	0.000	0.00	0.0000	0.00	0.00	0.0000	
10	9	O3/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
10	10	R3	1.280	37.51	0.0341	75.35	46.81	1.5976	
10	11	O4/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
10	12	R4	0.000	0.00	0.0000	72.10	54.15	0.0000	
			==mₑs===			=a=-=--=	========	========	
Cooper Mill			38.840			208.43	162.18	9.9582	0.34%

Stand		Type	MeanStdDet	Sta-ha	Det/ha92	92ha	96ha	96ha*(Det/ha92)	
11	1	O1/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
11	2	O1/RD	0.000	0.00	0.0000	0.00	0.00	0.0000	
11	3	O1/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
11	4	O2/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
11	5	O2/RD	0.000	0.00	0.0000	12.37	0.00	0.0000	
11	6	O2/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
11	7	R2	0.000	0.00	0.0000	20.01	0.00	0.0000	
11	8	O3/RD	0.000	0.00	0.0000	0.00	0.00	0.0000	
11	9	O3/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
11	10	R3	0.000	62.51	0.0000	150.84	91.06	0.0000	
11	11	O4/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
11	12	R4	0.000	0.00	0.0000	142.11	40.84	0.0000	
			---------			========	========	========	
Yager North			0.000			325.33	131.90	0.0000	0.00%

Stand		Type	MeanStdDet	Sta-ha	Det/ha92	92ha	96ha	96ha*(Det/ha92)	
12	1	O1/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
12	2	O1/RD	0.000	0.00	0.0000	0.00	0.00	0.0000	
12	3	O1/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
12	4	O2/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
12	5	O2/RD	0.000	0.00	0.0000	0.00	0.00	0.0000	.
12	6	O2/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
12	7	R2	9.200	25.00	0.3679	56.33	23.45	8.6293	
12	8	O3/RD	0.000	0.00	0.0000	0.00	0.00	0.0000	
12	9	O3/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
12	10	R3	11.840	200.04	0.0742	223.95	106.66	7.9125	
12	11	O4,/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
12	12	R4	0.310	75.01	0.0041	500.45	275.74	1.1395	
			=-wℓ----			=-e====m=	---------	========	
Yager Cr · Rd 3			2↓.350			780.73	405.85	17.6813	0.6↓%

Stand		Type	MeanStdDet	Sta-ha	Det/ha92	92ha	96ha	96ha*(Det/ha92)	
13	1	O1/R	62.490	100.02	0.6248	44.00	43.96	27.4646	
13	2	O1/RD	20.190	100.02	0.2019	65.10	63.96	12.9112	
13	3	O1/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
13	4	O2/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
13	5	O2/RD	27.300	62.51	0.4367	38.91	27.32	11.9330	
13	6	O2/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
13	7	R2	1.650	50.01	0.0330	17.65	8.22	0.2712	
13	8	O3/RD	0.000	0.00	0.0000	23.79	23.79	0.0000	
13	9	O3/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
13	10	R3	18.630	87.52	0.2129	150.29	75.21	16.0100	
13	11	O4/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
13	12	R4	0.000	0.00	0.0000	344.56	227.81	0.0000	
Allen Cr ·			========			=====we=	========	=====mm-	
Below Rd 3			130.260			684.30	470.27	68.5901	2.36%

Stand		Type	MeanStdDet	Sta-ha	Det/ha92	92ha	96ha	96ha*(Det/ha92)	
14	1	O1/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
14	2	O1/RD	2.840	187.53	0.0151	130.48	114.90	1.7401	
14	3	O1/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
14	4	O2/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
14	5	O2/RD	10.710	175.03	0.0612	48.28	37.58	2.2996	
14	6	O2/D	0.000	0.00	0.0000	5.13	5.13	0.0000	
14	7	R2	0.000	0.00	0.0000	0.00	3.99	0.0000	
14	8	O3/RD	0.000	0.00	0.0000	8.92	5.56	0.0000	
14	9	O3/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
14	10	R3	6.750	50.01	0.1350	167.21	85.56	11.5484	
14	11	O4/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
14	12	R4	0.000	0.00	0.0000	252.43	136.73	0.0000	
			--------			=========	===a====	===w=eW=	
Owl Cr			20.300			612.45	389.45	15.5881'	0.54%

Stand		Type	MeanStdDet	Sta-ha	Det/ha92	92ha	96ha	96ha*(Det/ha92)	
15	1	O1/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
15	2	O1/RD	40.830	125.02	0.3266	35.01	35.00	11.4318	
15	3	O1/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
15	4	O2/R	0.000	0.00	0.0000	0.00	0.00	0 .oooo	
15	5	O2/RD	6.690	37.51	0.1784	17.96	17.96	3.2030	
15	6	O2/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
15	7	R2	40.190	87.52	0.4592	30.03	36.27	16.6575	
15	8	O3/RD	0.000	0.00	0.0000	0.00	0.00	0.0000	
15	9	O3/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
15	10	R3	23.650	250.05	0.0946	154.45	149.02	14.0943	
15	11	O4/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
15	12	R4	9.790	75.01	0.1305	281.69	275.38	35.9397	
			---------			========	=======	-----a--	
Grizzly · Bemis			121.150			519.14	513.63	81.3263	2.80%

Stand		Type	MeanStdDet	Sta-ha	Det/ha92	92ha	96ha	96ha*(Det/ha92)	
16	1	O1/R	85.490	75.01	1.1397	64.23	22.87	26.0661	
16	2	O1/RD	0.000	0.00	0.0000	0.00	0.00	0.0000	
16	3	O1/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
16	4	O2/R	0.000	12.50	0.0000	9.96	1.86	0.0000	
16	5	O2/RD	0.000	0.00	0.0000	0.00	0.00	0 . 0 0 0 0	
16	6	O2/D	0.000	0.00	0 .oooo	0.00	0.00	0.0000	
16	7	R2	0.000	0.00	0.0000	0.00	0.00	0.0000	
16	a	O3/RD	0.000	0.00	0.0000	2.80	0.00	0.0000	
16	9	O3/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
16	10	R3	0.000	0.00	0.0000	10.06	49.02	0.0000	
16	il	O4/D	0.000	0.00	0 .oooo	0.00	0.00	0.0000	
16	12	R4	0.000	0.00	0.0000	14.89	30.16	0.0000	
			========			========	========	========	
Nanning			95.490			101.94	103.91	26.0661	0.90%

Stand		Type	MeanStdDet	Sta-ha	Det/ha92	92ha	96ha	96ha*(Det/ha92)	
17	1	O1/R	0.170	25.00	0.0068	4.39	4.39	0.0299	
17	2	O1/RD	0.740	25.00	0.0296	6.65	6.65	0.1969	
17	3	O1/D	0.000	0.00	0 .oooo	0.00	0.00	0.0000	
17	4	02/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
17	5	O2/RD	19.140	150.03	0.1209	26.29	26.21	3.1696	
17	6	02/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
17	7	R2	0.000	12.50	0.0000	0.59	0.58	0.0000	
17	8	O3/RD	0.000	0.00	0.0000	0.00	0.00	0.0000	
17	9	03/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
17	10	R3	0.000	0.00	0.0000	0.00	0.00	0.0000	
17	11	04/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
17	12	R4	0.680	37.51	0.0181	82.65	68.05	1.2337	
Monument ·			========			========	==e==w==	====em=m	
Dean Cr			19.730			120.57	105.88	4.6301	0.16%

Stand		Type	MeanStdDet	Sta-ha	Det/ha92	92ha	96ha	96ha*(Det/ha92)	
18	1	O1/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
18	2	O1/RD	0.000	0.00	0.0000	0.00	0.00	0.0000	
18	3	O1/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
18	4	02/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
18	5	O2/RD	3.970	87.52	0.0454	32.37	11.25	0.5101	
18	6	02/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
18	7	R2	0.000	0.00	0.0000	0.00	0.00	0.0000	
18	8	O3/RD	0.000	0.00	0.0000	0.00	0.00	0.0000	
18	9	03/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
18	10	R3	0.000	0.00	0.0000	0.00	3.93	0.0000	
18	11	04/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
18	12	R4	0.000	0.00	0.0000	0.00	0.00	0.0000	
			========			m==m==a=	---------	========	
Dean Cr. South			3.970			32.37	15.18	0.5101'	0.02%

Stand		Type	MeanStdDet	Sta-ha	Det/ha92	92ha	96ha	96ha*(Det/ha92)	
19	1	O1/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
19	2	O1/RD	0.000	0.00	0.0000	0.00	0.00	0.0000	
19	3	O1/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
19	4	02/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
19	5	O2/RD	0.000	0.00	0.0000	0.00	0.00	0.0000	
19	6	02/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
19	7	R2	0.000	0.00	0.0000	0.00	0.00	0.0000	
19	8	O3/RD	0.000	0.00	0.0000	0.00	0.00	0.0000	
19	9	03/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
19	10	R3	59.400	237.54	0.2501	171.54	65.28	16.3240	
19	11	04/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
19	12	R4	0.000	12.50	0.0000	209.95	108.21	0.0000	
			========			========	========	========	
Jordan Cr.			59.400			381.49	173.49	16.3240	0.56%

Stand		Type	MeanStdDet	Sta-ha	Det/ha92	92ha	96ha	96ha*(Det/ha92)	
20	1	O1/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
20	2	O1/RD	0.000	0.00	0.0000	0.00	0.00	0.0000	
20	3	O1/D	0.000	37.51	0.0000	13.20	13.20	0.0000	
20	4	02/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
20	5	O2/RD	0.000	0.00	0.0000	0.00	0.00	0 . 0 0 0 0	
20	6	02/D	6.310	37.51	0.1682	30.00	23.51	3.9550	
20	7	R2	0.000	0.00	0.0000	0.00	0.00	0.0000	
20	8	O3/RD	0.000	0.00	0.0000	0.95	0.95	0.0000	
20	9	03/D	0.610	12.50	0.0488	24.45	21.68	1.0578	
20	10	R3	8.050	12.50	0.6447	66.20	66.20	42.6753	
20	11	04/D	0.000	0.00	0.0000	40.11	40.10	0 .oooo	
20	12	R4	0.000	0.00	0.0000	8.78	7.61	0.0000	
			========			========	-w==e===	========	
Larabee Cr.			14.980			183.69	173.25	47.6881	1.64%

Stand		Type	MeanStdDet	Sta-ha	Det/ha92	92ha	96ha	96ha*(Det/ha92)	
21	1	O1/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
21	2	O1/RD	0.000	0.00	0.0000	0.00	0.00	0.0000	
21	3	O1/D	0.000	9.00	0.0000	0.00	0.00	0.0000	
21	4	O2/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
21	5	O2/RD	0.000	0.00	0.0000	0.00	0.00	0.0000	
21	6	O2/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
21	7	R2	2.260	37.51	0.0603	3.31	3.31	0.1996	
21	8	O3/RD	0.000	0.00	0.0000	0.00	0.00	0.0000	
21	9	O3/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
21	10	R3	1.870	87.52	0.0214	29.70	8.10	0.1730	
21	11	O4/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
21	12	R4	1.120	50.01	0.0224	149.37	85.22	1.9085	
			========			========	========	========	
Chadd Cr.			5.250			182.38	96.63	2.2811	0.08%

Stand		Type	MeanStdDet	Sta-ha	Det/ha92	92ha	96ha	96ha*(Det/ha92)	
22	1	O1/R	0.000	25.00	0.0000	12.53	5.17	0.0000	
22	2	O1/RD	0.000	50.01	0.0000	23.11	16.61	0.0000	
22	3	O1/D	0.000	212.54	0.0000	166.44	88.31	0.0000	
22	4	O2/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
22	5	O2/RD	0.910	225.04	0.0040	88.24	45.88	0.1855	
22	6	O2/D	0.000	450.08	0.0000	411.65	345.75	0.0000	
22	7	R2	0.000	50.01	0.0000	252.47	136.40	0.0000	
22	8	O3/RD	0.000	62.51	0.0000	37.85	29.82	0.0000	
22	9	O3/D	0.000	212.54	0.0000	596.88	540.09	0.0000	
22	10	R3	IO.220	450.08	0.0227	1719.75	913.06	20.7329	
22	11	O4/D	0.000	87.52	0.0000	809.46	741.70	0.0000	
22	12	R4	2.170	462.59	0.0047	6112.21	3924.41	18.4095	
All Remaining			========			========	========	======aw	
Palco			13.300			10230.59	6787.20	39.3279	1.36%

Stand		Type	MeanStdDet	Sta-ha	Det/ha92	92ha	'96ha	96ha*(Det/ha92)	
23	1	O1/R	588.810	637.62	0.9235	585.66	585.66	540.8316	
23	2	O1/RD	285.950	1050.19	0.2723	2859.38	2859.38	778.5612	
23	3	O1/D	0.000	12.50	0.0000	43.72	43.72	0.0000	
23	4	O2/R	0.000	0.00	0.0000	14.17	14.17	0.0000	
23	5	O2/RD	0.000	0.00	0.0000	482.06	482.06	0.0000	
23	6	O2/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
23	7	R1/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
23	8	R1/RD	0.000	0.00	0.0000	32.99	32.99	0.0000	
23	9	R1/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
23	10	R2/R	0.000	0.00	0.0000	8.96	8.96	0.0000	
23	11	R2/RD	0.000	0.00	0.0000	267.48	267.48	0.0000	
23	12	R2/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
Park North -			==e=e===			========	========	========	
Park Central			874.760			4294.42	4294.42	1319.3928	45.48%

Stand		Type	MeanStdDet	Sta-ha	Det/ha92	92ha	96ha	96ha*(Det/ha92)	
25	1	O1/R	16.920	100.02	0.1692	84.81	84.81	14.3467	
25	2	O1/RD	2.420	437.58	0.0055	2524.06	2524.06	13.9591	
25	3	O1/D	0.000	150.03	0.0000	173.06	173.06	0.0000	
25	4	O2/R	0.000	0.00	0.0000	10.05	10.05	0 .0000	
25	5	O2/RD	0.000	0.00	0.0000	1215.26	1215.26	0 . 0 0 0 0	
25	6	O2/D	0.000	0.00	0.0000	126.16	126.16	0.0000	
25	7	R1/R	0.000	62.51	0.0000	0.00	0.00	0.0000	
25	8	R1/RD	0.000	12.50	0.0000	119.33	119.33	0 .0000	
25	9	R1/D	0.000	9.00	0.0000	0.00	0.00	0 .0000	
25	10	R2/R	0.000	0.00	0.0000	1.53	1.53	0.0000	
25	11	R2/RD	0.000	12.50	0.0000	696.61	696.61	0.0000	
25	12	R2/D	0.000	0.00	0.0000	13.19	13.19	0.0000	
			-_-m==e=			========	========	========	
Park South			19.340			4964.06	4964.06	28.3058	0.98%

Stand		Type	MeanStdDet	Sta-ha	Det/ha92	92ha	96ha	96ha*(Det/ha92)	
26	1	O1/R	0.000	75.01	0.0000	0.00	0.00	0.0000	
26	2	O1/RD	0.000	0.00	0.0000	103.95	103.95	0.0000	
26	3	O1/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
26	4	02/R	0.000	0.00	0.0000	0.00	0.00	0.0000	.
26	5	O2/RD	0.000	0.00	0.0000	14.35	14.35	0.0000	
26	6	02/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
26	7	R1/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
26	8	R1/RD	0.000	0.00	0.0000	5.55	5.55	0.0000	
26	9	R1/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
26	10	R2/R	0.000	0.00	0.0000	0.00	0.00	0.0000	
26	11	R2/RD	0.000	0.00	0.0000	401.36	401.36	0.0000	
26	12	R2/D	0.000	0.00	0.0000	0.00	0.00	0.0000	
			===we-==			--------	========	========	
Park West			0.000			525.21	525.21	0.0000	0.00%

LIST OF FIGURES

FIGURE 1.   Marbled Murrelet survey stations on Pacific Lumber **Company lands (based** on the 1996 vegetation), and the Humboldt Redwoods and **Grizzly** Creek Redwoods state parks. (not included herein)

FIGURE 2. A sample stand with survey stations shown and **the 200-m** radius circles around each station. (not included herein)

FIGURE 3.   On Pacific Lumber Company lands, the relationships of the 12 habitat groupings, as applied in Method 1, the "Most Likely Habitat" method.

FIGURE 4: Within Humboldt **Redwoods** State **Park,** the relationships of the 12 habitat groupings, as applied in the West **Likely Habitat" method (Method 1).**

FIGURE 5.   **Comparison** of the three methods **of** designation of murrelet observations on Pacific Lumber Company lands and Humboldt Redwoods State Park.

FIGURE 6. **A** comparison of stand area and Bird Value for ranking potential value of the stands.

FIGURE 7.   Percent of bird population in the various **stands,** based on either all detections, or only those involving occupied **detections.**

FIGURE 3.   On Pacific Lumber Company lands, the relationships of
the 12 habitat groupings, as applied in Method 1, the "Most
Likely Habitat" method.

     Each grouping was a combination of canopy coverage **grouping**
(horizonal rows) and structure-species type grouping (columns).
The numbers in parentheses are the habitat type numbers used in
the analyses.   Each column corresponds to a structure (old-growth
or residual) and species type (Douglas-fir, redwood, or a
redwood/Douglas-fir combination).   The combined rows and columns
are the habitat types.

     In Method 1, we allocated a station's number of detections
to the habitat type, considered in our judgment, "Most Likely" to
have murrelets occurring within the 200-m habitat circle around
the **station (See Table** 2 for habitat type descriptions).
Primarily, for any comparison between two types in different
canopy cover classes, a higher level of canopy cover was
considered a more likely habitat type for murrelets. For
example, between 01/DR (old-growth Douglas-fir/redwood, over 75%
canopy) and 04/D (old-growth Douglas-fir, under 25% canopy)
detections were assigned to 01/DR.   Second, within a canopy class
(i.e., within one row on the figure), detections were assigned to
the type with the larger area within the 200-m station habitat
circle.   This rule would apply when comparing, for example, 01/R
and 01/D, or with 02/RD and R2.

FIGURE 3. **On** Pacific Lumber Company lands, the relationships of the 12 habitat groupings, as applied in Method 1, the "Most Likely Habitat' method.
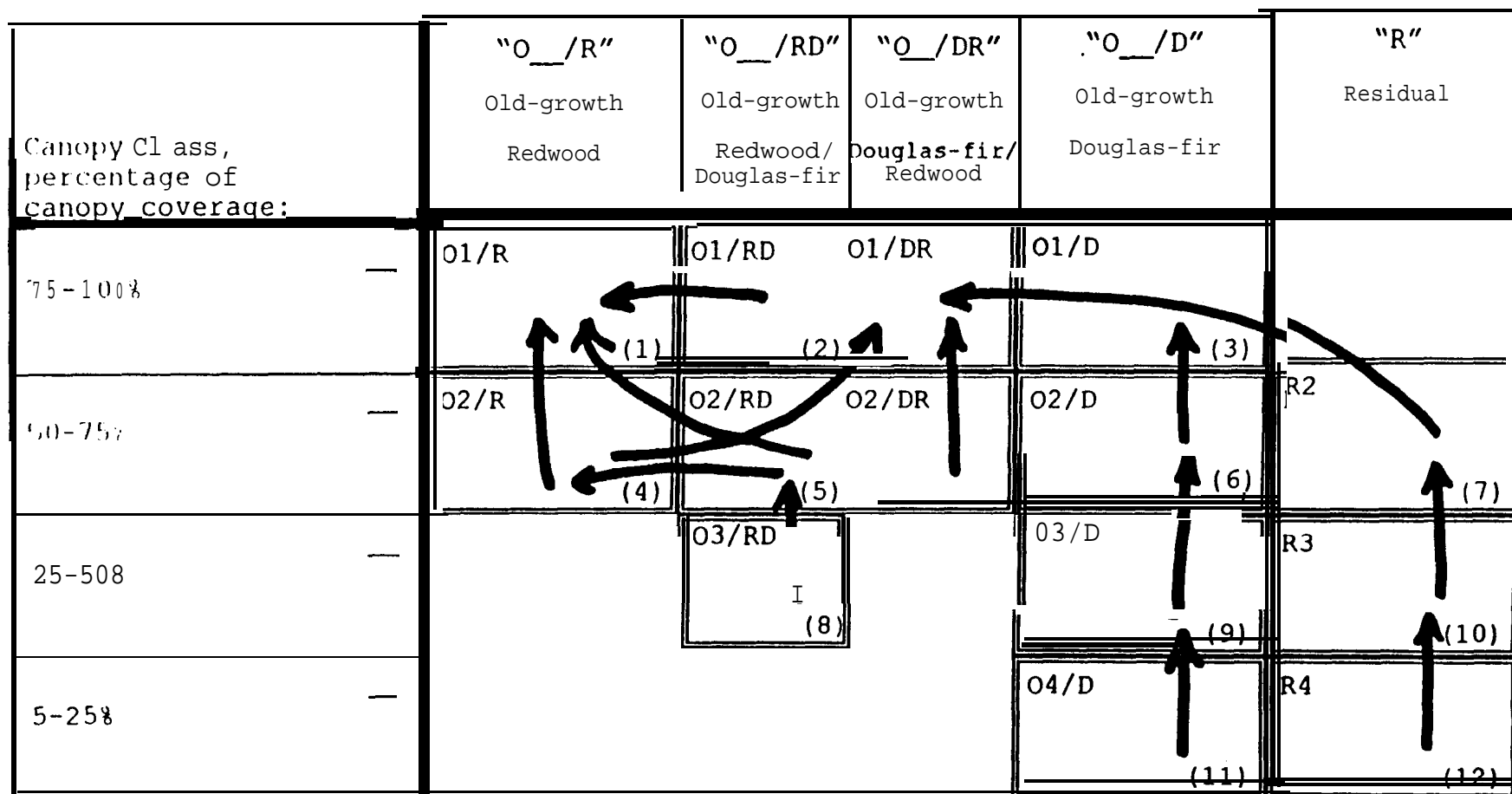
Canopy Class, percentage of canopy coverage:	"O__/R" Old-growth Redwood	"O__/RD" Old-growth Redwood/ Douglas-fir	"O__/DR" Old-growth Douglas-fir/ Redwood	."O__/D" Old-growth Douglas-fir	"R" Residual
75-100% —	O1/R	O1/RD	O1/DR	O1/D	
50-75% —	O2/R	O2/RD	O2/DR	O2/D	R2
25-50% —		O3/RD		O3/D	R3
5-25% —				O4/D	R4

(1) (2) (3)
(4) (5) (6) (7)
(8) (9) (10)
(11) (12)

FIGURE 4.   Within Humboldt Redwoods State Park, the relationships
of the 12 habitat groupings, as applied in the "Most Likely
Habitat" method (Method 1).

     Each row corresponds to a timber class determined by the
structure (old-growth or residual) and the canopy cover class
 (over 50 percent or under 50 percent).   Each column corresponds
to an understory/ground cover class (1, 2, 3, 4, and 5) as used
by Emery.   Numbers in parentheses are the habitat type numbers
used in the analysis.
     In Method 1, we allocated a station's detection value to the
 "Most Likely" habitat type occurring within the 200-m station
habitat circle (see Table 2 for habitat type descriptions).   The
decision process for determining which habitat is "more likely"
in the State Park is a combination of two steps, row-wise and
column-wise.
     In general, when comparing rows, the 01 row is considered to
contain the most likely types, so, when comparing two types, if
one of them is 01, then the detections were assigned to the 01
type.   The Rl row is considered the next most likely row.
Comparing an Rl type with another, lower type, results in the Rl
type getting the detection value.   For example, between Rl/RD and
02/RD, the detections would be assigned to Rl/RD.
     When comparing two types, if neither is an 01 type nor an Rl
type, and one is from the 02 row and the other from the R2 row,
the detections are assigned to the type which comprises the
larger area within the 200-m station habitat circle.
     Concerning understory/ground cover type, when comparing two
types where one is R and the other is RD (Emery 2, 3, or 4), then
R is considered more likely.   Otherwise, the understory/ground
cover type with the larger area is assigned the detections.

FIGURE 4. Within Humboldt Redwoods State Park, the relationships of the 12 habitat groupings, as applied in the "Most Likely Habitat" method (Method 1).

Understory/ groundcover Group:		"R"	"RD" MIX	"RD" MIX ,	"RD" MIX	"D"
	UNKNOWN	Redwood (Sequoia sempervirens)	Redwood/ Douglas-fir/ Salal (Gaultheria shallon)	Redwood/ Douglas-fir/ Huckleberry (Vaccinium ovatum)	Redwood/ Douglas-fir/ Madrone (Arbutus menziesii)	Douglas-fir (Pseudotsuga menziesii)
Timber Class	Emery 0	Emery 1	Emery 2	Emery 3	Emery 4	Emery 5
"0" UNKNOWN						
"O 1 " Old-growth 50-100%		31/R	O1/RD (2)			O1/D (3)
"R 1 " Residual 50-100%		R1/R (7)	R1/RD (8)			R1/D (9)
"O 2" Old-growth 0-50%		32/R (4)	O2/RD (5) I			02/D I (6)
"R 2 " Residual 0-508		R2/R (10)	R2/RD (11)			R2/D (12)

FIGURE 5. Comparison of the three methods of **designation Of murrelet observations on Pacific Lumber company lands** and Humboldt Redwoods State Park.

     For each stand **(as** defined within the green outlines on Fig. 1) the detection value at **each** station (i.e., the mean of the standardized detections of each survey at that **station) was** attributed to the different habitat types surrounding the station by use of three different methods. These **Mean** Standardized Detections **were** then averaged by habitat type (Table 2) for each stand, then extrapolated by habitat type to the entire stand. A total "Bird Value" for each stand was produced by *summing* these extrapolated detections over all 12 habitat types. For each of the methods, these stand Bird Values were totaled over the entire Bioregion, and the percentage that each stand contributed to the total was calculated for use in this bar graph.
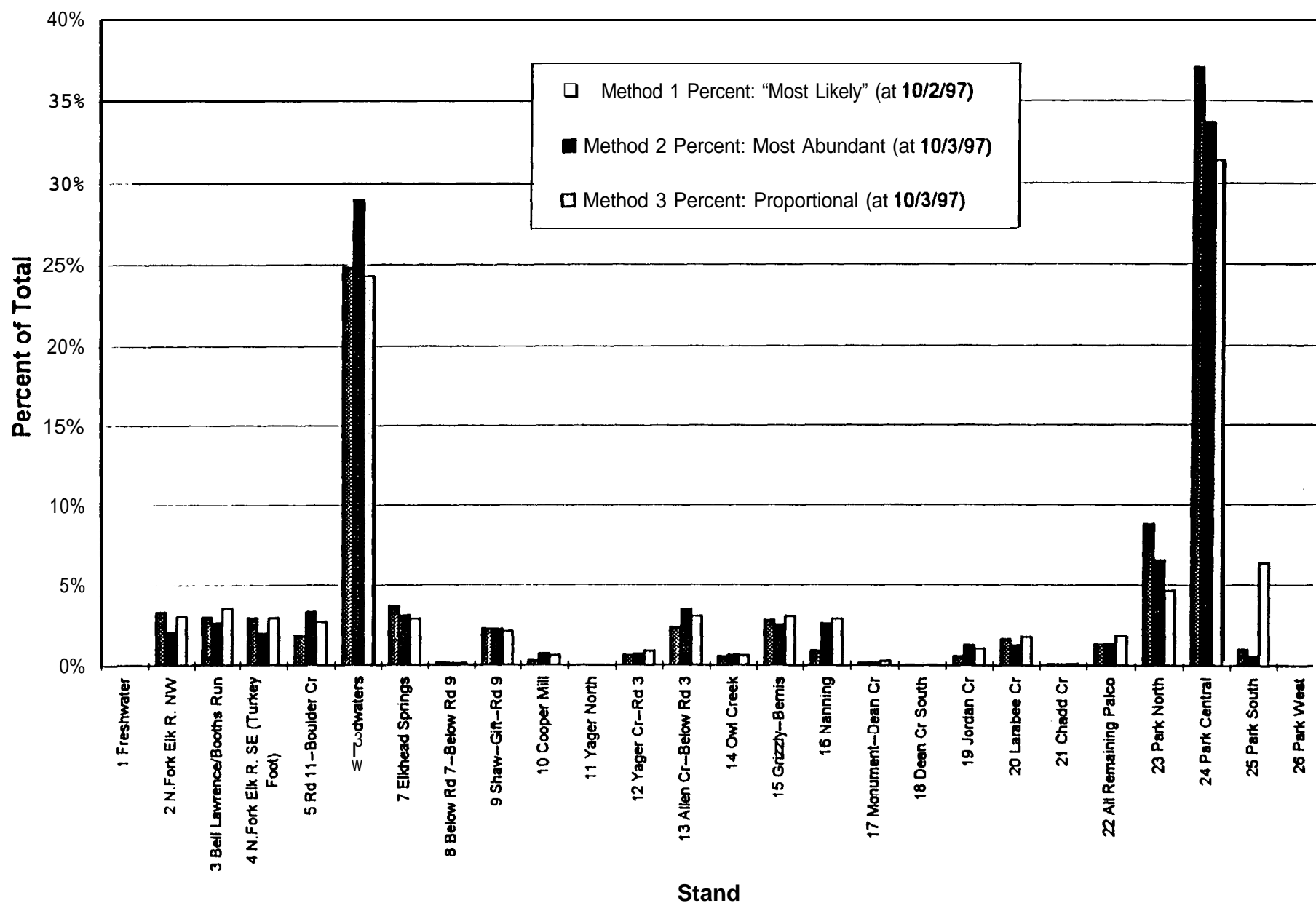
FIGURE 5. Comparison of the three methods of designation of murrelet observations on Pacific Lumber Company lands and Humboldt Redwoods State Park.
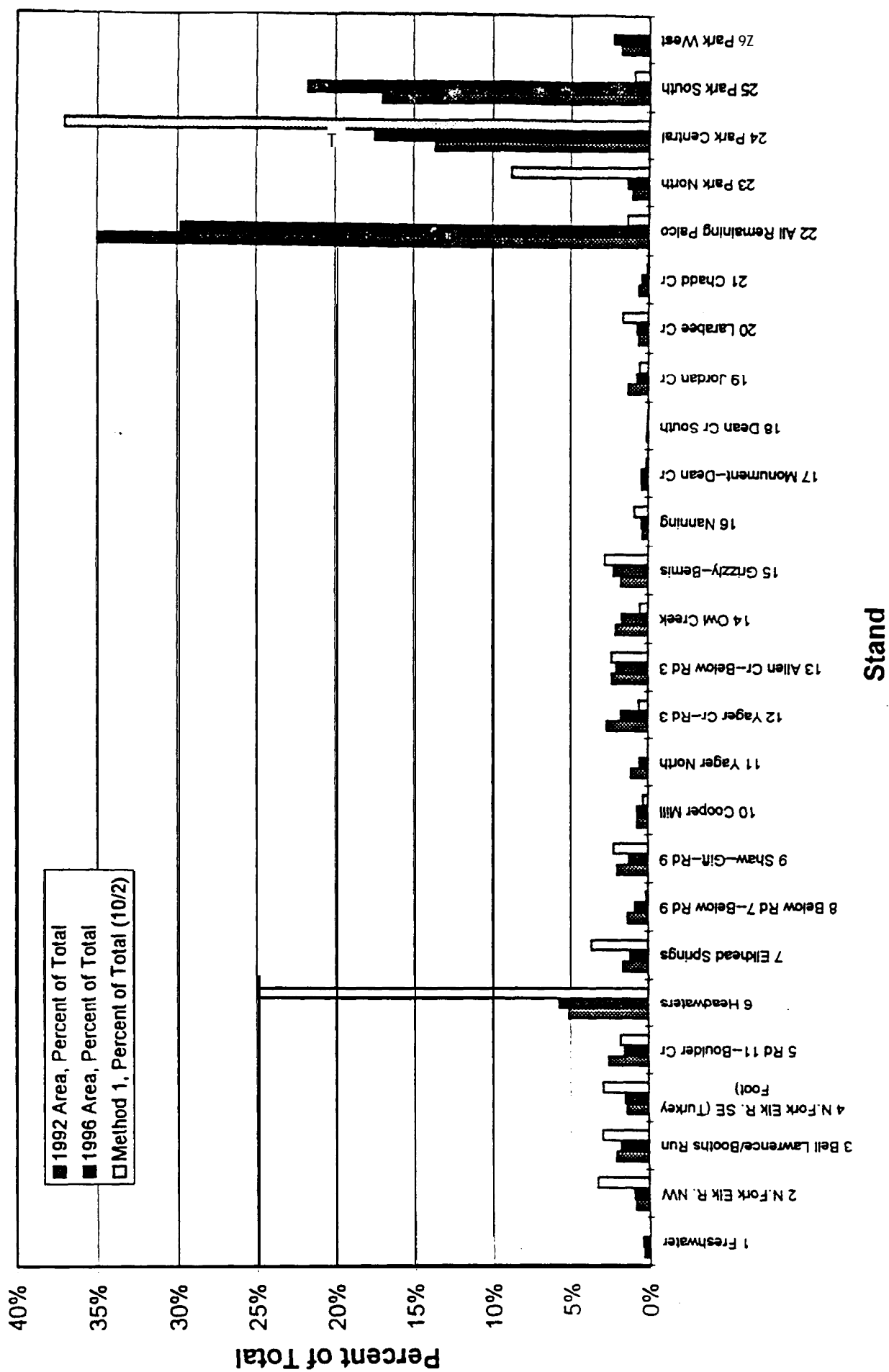
FIGURE 6.   A comparison of relative stand area and Method 1 Bird Value, by stand.

STAND CLASS DESCRIPTION
Humboldt Redwoods State Park

0 1 - Uncut old growth, 50 - 100% crown cover

0 2 - Uncut old growth, less than 50% crown cover

OYl - Uncut old growth with intermingled young growth, 50 - 100 % crown cover

OY2 - Uncut old growth with intermingled young growth, less than 50% crown cover

Rl - Cutover containing mostly old growth residual trees, 50 - 100 % crown cover

R2 - Cutover containing mostly old growth residual trees, less than 50% crown cover

RYl - Cutover containing old growth residual trees with considerable young growth trees, 50 - 100% crown cover. Crown cover density applies to old growth residual trees only

RY2 Cutover containing old growth residual trees with considerable young growth trees, less than 50% crown cover. Crown cover density applies to old growth residual trees only

Yl - Young growth stands, diameters generally 24"+, 50 - 100% crown cover

Y2 - Young growth stands, diameters generally 24"+, less than 50% crown cover.

P - Pole and sapling stands, diameters generally less than 24", all densities

N - Non-timber, hardwoods and brush

NC - Arcas not classified because of absence of stereo coverage

Note: Species are not identified in this system.